Space Weather Technical Forecast

Issued on Tuesday, 13 August 2024 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: A chance of G1-G2/Minor-Moderate geomagnetic storms day 1 and day 2 (13/14 Aug). M-class flares likely with a slight chance of isolated X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a single low level M-class flare observed, originating from AR3784 in the northeast. There are ten sunspot regions visible on the disc. AR3780 situated in the southwest remains the largest region, displaying a complex magnetic structure with at least two weak delta spots, it has shown some intermediate spot emergence in recent hours. AR3784 in the northeast remains large and complex, now all contained within the penumbra of one singular spot therefore containing numerous delta spots in a somewhat unusual configuration. AR3777 is becoming increasingly difficult to analyse due to foreshortening as it begins it's rotation around the southwest limb. All other spots are small and simple.

A suspected filament eruption was observed in the southwest of the disk around 13/0800UTC, though any CME is proving slow to appear in imagery and is therefore yet to be analysed. No further Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind parameters measured at L1 by DSCOVR/ACE were indicative of active CME magnetic cloud conditions, with a very gradual exit. Solar wind speeds were slightly elevated throughout, but gradually eased from around 470 km/s to 420 km/s. Density was average or above, with a peak of 25ppcc observed at 13/2310UTC. The Interplanetary Magnetic Field, Bt, was strong, peaking at 22nT at 13/0350UTC before slowly easing to moderate to end the period. The north-south component, Bz, started negative, around -17nT before slowly rotating to positive by 13/0000UTC and remaining so thereafter, rising to +17nT. Phi angle was mostly negative before becoming mostly positive (away from the Sun) after 13/0340UTC. Geomagnetic activity was initially at G4/Severe storm (Kp8) levels, before gradually becoming Quiet to Unsettled (Kp 2) to end the period.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background below the S1 Minor Radiation Storm threshold. High energy electron flux (greater than 2MeV) observed at GOES16 were predominantly at background levels. The 24-hour fluence was steady and well below the Active threshold, with 1.01e6 integrated pfu observed at 13/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast, with M-class flares considered likely and a slight chance of an isolated X-class flare.

Solar Wind /Geomagnetic Activity: Influence from the CME magnetic cloud is continuing to wane, with all solar wind parameters experiencing a gradual decline. There remains a chance of the late arrival of up to two CMEs later day 1 or day 2 (13/14 Aug) though these are thought to have most likely been encompassed within the CME mag cloud experienced 12 Aug. Barring any CME influence, the fast wind from coronal hole 58 is likely to pass north of the Earth-Sun line with no

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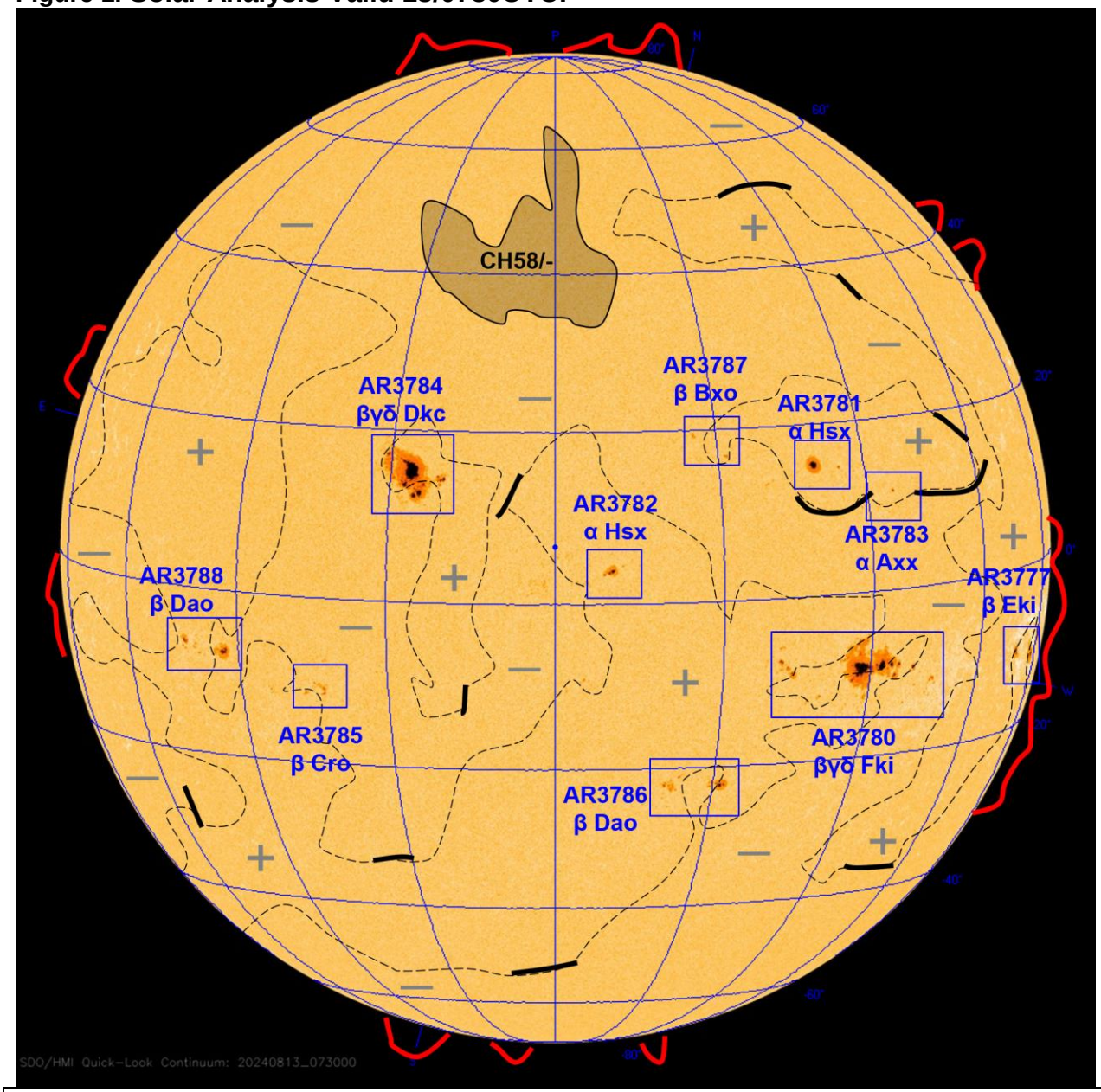
appreciable enhancement expected, therefore solar winds should trend from slightly elevated back to slow-ambient.

Geomagnetic activity is expected to be mainly Quiet to Active (Kp 2-4) through the period. There remains a chance of up to two glancing CMEs through the remainder of day 1 or early day 2 (13/14 Aug), therefore bringing a chance of G1-G2/Minor-Moderate Storming (Kp 5-6), with a very slight chance of a G3/Strong storm (Kp 7) interval.

Energetic Particles / Solar Radiation: A heightened risk of flare activity brings a chance of reaching/exceeding the S1 Minor Radiation storm level should any significant flares occur from active regions in the western hemisphere. The high energy electron flux is forecast to be at mostly background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 13/0730UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

Influence from the CME magnetic cloud is continuing to wane, with all solar wind parameters experiencing a gradual decline. This trend is expected to continue through the period, though there remains some uncertainty whether two CMEs arrived within the magnetic cloud on 12 Aug or if their late arrival remains possible. These were the CMEs from the M4.5 flare from AR3777 at 09/2123 UTC, and the M5.3 flare from AR3780 at 10/0237UTC. These CMEs were expected to combine, with a joint arrival time around 13/0300UTC +/-8hrs. A discontinuity in the magnetic cloud observed around 13/0700UTC may be the very early arrival of these CMEs, which is currently thought to be the most likely situation given the previous large and fast CME acting to pull these CMEs through. On the other hand, a late should be accounted for, and given the already elevated parameters may more easily trigger geomagnetic storms, though this is currently not the favoured situation.

No other Earth directed CMEs are expected in the period, with the fast wind from coronal hole 58 likely to pass north of the Earth-Sun line with no appreciable enhancement expected, therefore solar winds trending back to slow-ambient.

Geomagnetic activity is expected to be mainly Quiet to Active (Kp 2-4) through the period. There remains a chance of up to two glancing CMEs through the remainder of day 1 or early day 2 (13/14 Aug), therefore bringing a chance of G1-G2/Minor-Moderate Storming (Kp 5-6), with a very slight chance of a G3/Strong storm (Kp 7) interval.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	30	10	10
Strong	G3	Yes	10	5	1	1
Severe	G4	Yes	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/2123	Partial	M4.5 flare	AR3777	633 km/s	13/0300UTC +8hrs	Either embedded in previous CME mag cloud or late.
Or10/0645	Partial	M5.3 flare	AR3780	750 km/s	13/0300UTC +8hrs	Either embedded in previous CME mag cloud or late.

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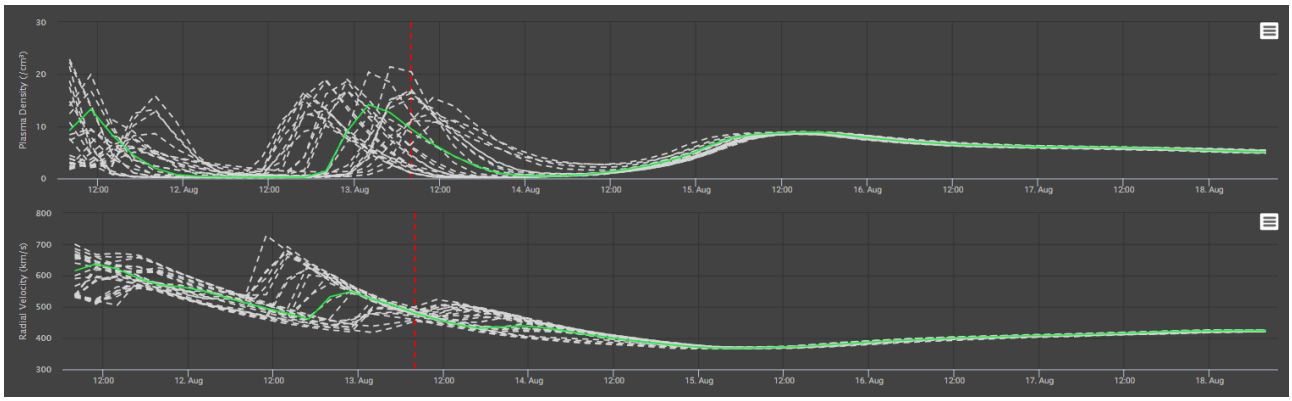
Figure 2: MOSWOC ENLIL Ensemble



Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate with a single low level M-class flare observed, originating from AR3784 in the northeast.
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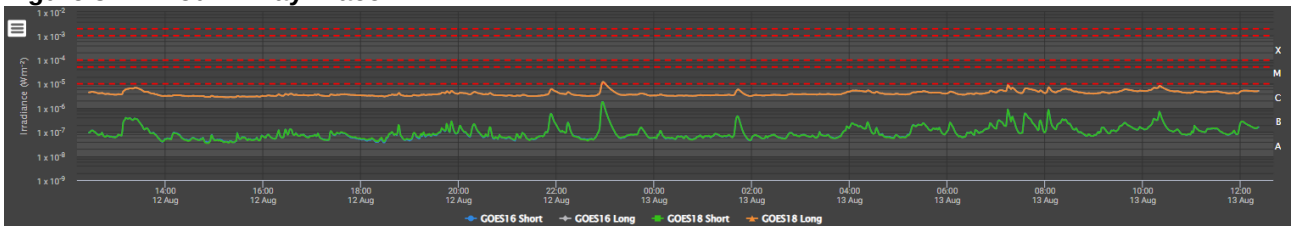
Further M-class flares are likely expected with a slight chance of an isolated X-class flare, these perhaps most likely from AR3780.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: 24 hour X-Ray Trace



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18, was at background throughout the period. Any strong flares will bring a chance of reaching/exceeding the S1 Minor Radiation storm level. The risk mainly from AR3780 and AR3777 currently in the western hemisphere, though this reducing by day 3 as AR3777 rotates well beyond the western limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	30	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

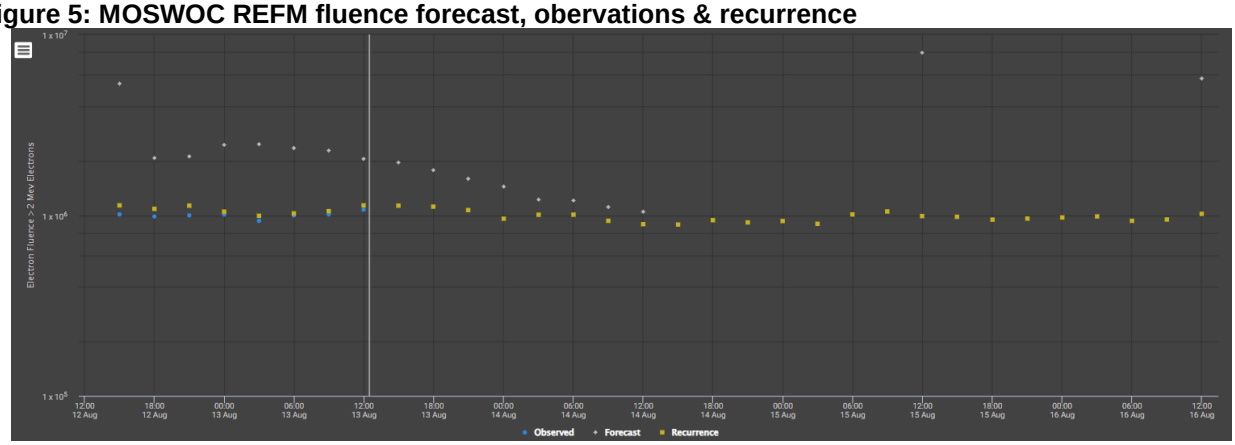
High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, is currently at background. The recent Strong and Severe geomagnetic storming on 12 Aug may see electron flux at GEO increase in time to moderate or even high levels given the potential for electron transfer from currently more highly changed regions below GEO.

The associated 24hr electron fluence is therefore currently expected to remain below Active (1e8 integrated pfu) levels throughout but with reducing confidence into the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM fluence forecast, obervations & recurrence



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